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PROGRESS REPORT
TO
OFFICE OF NAVAL RESEARCH

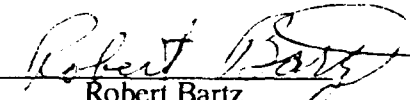
FOR CONTRACT NO: N00014-90-C-0123

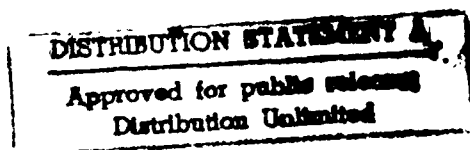
TITLE: Development of an Expendable Particle Sensor

ITEM NO: 0001AG

DATE: 30 November 92




Robert Bartz
Principal Investigator



93-02339



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PROGRESS REPORT:

Development of an Expendable Particle Sensor

Sea Tech Inc.

Contract No. N00014-90-C-0123

Item No. 0001AG

INTRODUCTION:

This report addresses progress on the Phase II Development of the Expendable Particle Sensor (EPS) for the time period from October through November 1992. Work during this time period focused on the reduction of data obtained at Santa Catalina Island related to the XOTD probe hydrodynamic stability. A video tape is provided with this report to document the hydrodynamic problems experienced with the proposed XOTD probe design.

RESULTS:

The video data starts by showing the outline dimensions of the XOTD probes. The tow tests follow which revealed hydrodynamic stability problems with the proposed XOTD probe. Included is tow test video data showing a ring fin design that improves the hydrodynamic stability of the XOTD probe. In July an opportunity arose that would allow Sea Tech to obtain free fall video data related to XOTD probe response. Sea Tech took advantage of this opportunity and with the cooperation of the Cousteau Society and Sparton of Canada has obtained video data showing the hydrodynamic performance of several expendable probe designs.

The video data taken on September 12, 1992 demonstrates the performance of several different probe designs as the probes fall through a 45' water column. A frame counter program was written to determine accurate frame time and allows for a detailed analysis of the video data. The frame counter indicates "seconds & 1/60 seconds," 1/60 second is the time for one video picture. Television displays video as two pictures per frame consequently timing resolution will be 1/30 second when viewing the video data. Pay particular attention to the video data from 39 seconds to 41 seconds, this data shows just how bad the response of the proposed XOTD probe can be, the probe is moving nearly horizontally through the water column for approximately 1.5 seconds. Probe spin rate is easily determined by viewing the white tape placed on one side of the probe and determining the time of one rotation.

The video data taken on September 13, 1992 also demonstrates the performance of several different probe designs as the probes fall through a 63' or 19.21 meter water column. To determine probe drop rate a flash strobe was triggered manually when the probe entered the water surface. This flash strobe and the frame counter along with the video data showing when the probe reaches the bottom permits reasonably accurate timing for probe drop rate. Extremely accurate drop rate accuracy is possible by triggering the flash strobe electronically.

The following table lists data for the first expendable probe drop test on Sunday, September 13, 1992. The first four probes were not video taped, they were on the bottom when the video data starts at 11:13.34. This was our first test using a flash strobe to provide accurate probe launch time. Viewing the video data, it is obvious that the probes were dropped too fast for the photographer to keep up, consequently data is incomplete for several probe deployments during this first test.

Table 1 First expendable probe drop test on Sunday

Probe ID	Type/Mod	Wire (Y/N)	Weight (gm)	C of G inches	Start seconds	Stop seconds	Spin RPM	Drop Rate meters/sec
H	no video							4 probes
S	no video							are
16	no video							on
13	no video							bottom
12	XBT-5	Y	980	2.85	no flash	7.59	360	
15	XBT-5	N	720	2.19	19.37	23.35	360	4.84
14	XBT-5/M2	N	716	2.19	33.19 ?	37.24	360	4.70
2	XOTD/M1	Y	784	3.40	46.36 ?	51.46	N/A	3.72
17	XBT-5	N	717	2.18	57.45 ?	64.26	214	2.87
4	XBT-4	Y	719	1.90	83.10	missed		
18	XBT-4/M1	Y	719	2.05	no flash	90.01	360	
6	XBT-4	N	608	1.65	97.17	missed		
19	XBT-4/M2	Y	715	2.00	no flash	104.28		
8	XBT-7	Y	717	2.10	no flash	109.29		
9	XBT-7	Y	719	2.10	118.31	121.52	450	5.73
5	XBT-4	Y	715	2.05	131.16	134.25	400	6.10
22	AXBT	N	702	0.75	144.23	157.52	N/A	1.42
20	AXBT	Y	839	1.03	no flash	168.12	N/A	
23	AXBT	N	699	0.77	no flash	181.50	N/A	
21	AXBT	Y	845	1.05	no flash	197.56	N/A	

The second test went much better, video is missing for only two probe deployments.

Table 2 Second expendable probe drop test on Sunday

Probe ID	Type/Mod	Wire (Y/N)	Weight (gm)	C of G inches	Start seconds	Stop seconds	Spin RPM	Drop Rate meters/sec
S	XCTD. Fin				no flash	282.23	675	
1	XOTD/M1	N	677	2.6	291.13	296.08	N/A	3.91
H	H-C Fin	N	?	?	306.08	311.27	N/A	3.61
15	XBT-5	N	720	2.19	317.56	321.41	360	5.12
2	XOTD	Y	784	3.40	342.12	347.05	N/A	3.93
16	XBT-5/M1	N	727	2.2	359.48 ?	365.02	N/A	3.67
I?	?	?	?	?	380.22	383.38	450	5.88
D	?	?	?	?	393.41	missed		
14	XBT-5	N	716	2.19	407.17	410.50	360	5.41
12	XBT-5	Y	980	2.85	427.59	431.28	450	5.51
13	XBT-5	Y	981	2.90	520.23	523.38	450	5.91

The third test was difficult to reduce, better planning is certainly needed to prevent this kind of problem in the future.

Table 3 Third expendable probe drop test on Sunday

Probe ID	Type/Mod	Wire (Y/N)	Weight (gm)	C of G inches	Start seconds	Stop seconds	Spin RPM	Drop Rate meters/sec
?	short				no flash	619.21	no spin	
?	short				no flash	620.48	no spin	
?	long				no flash	672.34	no spin	
?	long ?				no flash	672.52	no spin	
?	2 Deployed				no flash	705.57		
S	Together				no flash	707.51		
?	long				739.46	744.01	275	4.52
?	long				missed	766.30	spins	
?	short				780.15	782.51	450	7.39
?	short				808.45	811.23	450	7.29
?	short				827.41	830.31	450	6.78
15	XBT-5	N	720	2.19	860.33	864.14	360	5.21
14	XBT-5	N	716	2.19	876.29	879.44	450	5.91
13	XBT-5	Y	981	2.85	886.51	no video		
I	2 Deployed				928.07	missed	450	?
D	Together				928.07	931.04	450	6.51
AXBT	2 Deployed				958.20	969.36		1.70
AXBT	Together				958.20	970.54		1.53
AXBT	2 Deployed				991.01	1002.27		1.68
AXBT	Together				991.01	1004.02		1.48
6	XBT-4	N	608	1.65	1012.53	1016.08	360	5.91
DP	solid disk				1046.28	1060.01	N/A	1.42
no tail					1072.40	missed		

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In the fourth and last test the sequence is correct, there is no confusion about what was dropped when as in the third test. The problem with this test was that the photographer did not obtain video data at the bottom for several probe deployments.

All probes for this test were deployed by throwing them approximately 3 meters up into the air and letting them fall at high velocity into the water. This was done to simulate normal shipboard deployment of expendable probes.

Table 4 Fourth expendable probe drop test on Sunday

Probe ID	Type/Mod	Wire (Y/N)	Weight (gm)	C of G inches	Start seconds	Stop seconds	Spin RPM	Drop Rate meters/sec
2	XOTD/M1	N	784	3.40	1155.41	1160.20	N/A	4.13
H	H-C Fin	N	?	?	1173.47	1178.37	N/A	3.97
12	XBT-5	Y	980	2.85	1206.13	1210.08	no see	4.90
14	XBT-5	N	716	2.19	1234.35	1238.06	no see	5.46
16	XBT-5/M1	N	727	2.2	1287.03	1291.02	no see	4.82
15	XBT-5	N	720	2.19	1326.09	1329.24	360	5.91
I?	?				1377.26	1380.44		5.82 ?
D?	?				?	?		
C?	?				?	?		
13	XBT-5	Y	981	2.85	1410.03	missed		
S	XCTD	N	?	?	1433.45	missed		
19	XBT-4/M2	Y	715	2.00	1460.17	missed		
8	XBT-7	Y	717	2.1	1477.19	missed		
5	XBT-4	Y	715	2.05	1499.55	missed		
4	XBT-4	Y	719	1.90	1522.10	1526.19	no see	4.63 ?
20	AXBt	Y	839	1.03	1551.58	1563.00	N/A	1.74
21	AXBt	Y	845	1.05	1551.58	1563.00	N/A	1.74
22	AXBt	N	702	0.75	1575.33	1588.02	N/A	1.54
23	AXBt	N	699	0.77	1575.33	1588.02	N/A	1.54
17	no tail fin	?	?	?	1598.04	1603.47	N/A	3.36